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Innovation and the geographical and functional dimensions of outsourcing: An empirical investigation based on Italian firm level data

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Abstract

The paper investigates the diversified patterns of outsourcing in the Lombardy region and relates them to the probability of introducing product and process innovation. Based on a large firm-level survey, we show that outsourcing processes are strongly regionally embedded and that offshoring is still a limited phenomenon. Outsourcing strategies are shown to have a positive impact on firms' innovation. In particular, the outsourcing of service activities contributes the most to innovation, thus suggesting that firms successfully pursue core strengthening strategies. Our econometric estimates show that both geographical and organizational proximity matter. Indeed, the positive association of services with innovation is strongly related to their regional dimension, which points toward the importance of local user-producer relationships. When outsourcing crosses national borders, keeping the outsourced activities at least loosely connected to the firm appears critical, as offshoring to non affiliated firms has a clear negative impact on innovation.

Keywords: Product Innovation, Process Innovation, Outsourcing, Offshoring

JEL Classification: D21, F23, L22, L23, O31, O32, O33

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1 Introduction

Analyses of spatial and functional distribution of activities along with studies on the coordination and systemic integration of resources and competences across organisational boundaries (e.g. open innovation; R&D networks; strategic alliances; strategic sourcing) are increasingly defining innovation literature (Brusoni et al. 2001; Chersbrough, 2006; Debresson and Amesse, 1991; Gulati, et al., 2000; Laursen and Salter, 2006; Narula, 2001; Powell et al. 1996; Prahalad and Hamel, 1990). The analytical appeal of the lone Schumpeterian entrepreneur fades, as innovation is ever more interpreted as the outcome of distributed activities and concurrence of diversified local and global specialisms. Increasing competence specialisation and greater systemic complexity account for the emergence of new organisational forms and coordination mechanisms across firms' boundaries, which concern an ever more diversified range of activities and functions. Coombs and Metcalfe (1998) explicitly refer to an increasing "distributedness" of production processes, which is followed and affected by a growing "distributedness" of innovation processes. As Coombs et al. (2003) point out, the vast majority of products are nowadays provided to the market through iterative sequences and complex interactions among a rich variety of agents, whose contributions are coordinated through arm's-length market arrangements or more intimate relationships, such as alliances or joint ventures.

Specialisation and market-mediated integration of complementary resources and competences stem in particular from pervasive processes of outsourcing or value chain fragmentation, across organisations and geographical boundaries. Over the last couple of decades, outsourcing has been significantly accelerating, turning into a defining character of the contemporary economic dynamics, driving structural change at firm, industry and country level. Instead of continually growing in size and scope, the modern "corporate model" has been leaning towards network-based typologies, with greater specialisation and focus on "core competences" combining with strategic sourcing and partnering. Most interestingly, an ever more diversified range of activities and functions has been the object of outsourcing decisions. Outsourcing strategies no longer concern only fairly specialised repetitive tasks; rather outsourcing options spread to a wide range of activities, including sensitive functions and knowledge-intensive tasks, such as design and R&D (Howells, 1999; Leiblein et al., 2002). This implies an increasing leverage of technology and knowledge from external sources, in the attempt to respond flexibly to pressures and challenges from competition.

The functional breadth of the outsourcing phenomenon is but one dimension of the complex emerging trend. The spatial distribution of outsourced activities, and the resulting geographical span of value chains, feature prominently in the debate. The international range of outsourcing, offshoring, has been attracting peculiar attention, as it contributes in shaping global value chains, affecting, beside firms organisation and performance, the insertion of regions and countries in the international division of labour (Grossman and Helpman, 2002; Gereffi and Sturgeon, 2004). However, outsourcing has firstly, and prominently, a local or domestic dimension. Deverticalisation concerns by a large extent, producers and suppliers related by proximity. Specific regional advantages and agglomeration effects have been largely debated in the literature as sources of local division of labour or cluster-centred flexible specialisation (e.g. Breschi and Malerba, 2001; Garofoli, 1993; Maskell, 2001; Morgan, 1997, 2004; Scott, 1988).

While there are a number of contributions relating outsourcing to firm productivity and there is a sizeable body of literature that elaborates on the determinants of innovation at the firm-level, empirical investigation relating innovation to outsourcing strategies is still rather sparse, or mostly focusing on the motives underlying outsourcing decisions (Girma and Görg, 2004; Kimura, 2002; Maskell et al., 2007; Mol, 2005; Tomiura, 2005). In both the managerial and economics fields, empirical assessments have been mostly concentrating on the correlation between deverticalisation and general measures of firm performance, such as labour productivity or financial outcomes (Gilley and Rasheed, 2000; Leiblein et al., 2002; Rothaemel et al. 2006). The empirical literature that considers the spatial dimension, investigating the impact on innovation of differently dispersed fragmentation processes, is mostly concentrated on the relevance of proximity and clustering (Boschma, 2005). On the other hand, offshoring effects on firm-level innovation performance are little investigated, at least on the basis of large samples, that provide representative insights on highly diversified economic systems, rather than on the strategies of specific actors, such as multinational companies.

The present contribution adds to the literature by exploring both the spatial and functional dimensions of the outsourcing trends which are transforming an advanced manufacturing region, relating this dynamics to firm-level innovation, in terms of both production and process innovativeness. It does so on the basis of a large firm-level dataset, that is representative of the regional economic structure of Lombardy, Italy's leading economic region. The empirical analysis therefore aims at assessing the impact of outsourcing, taking into account its breadth, that is, the types of activities concerned, differentiating between production, R&D and services. Furthermore, for each of those areas of activity, the research explores the geographical span of the fragmentation process, assessing quantitative relevance and impact on innovation performance of domestic outsourcing, and particularly of regionally confined division of labour, and offshoring. The investigation about offshoring is further detailed by combining the spatial dimension with the organisational one, that is, assessing the relevance of organisational proximity, in the form of intra-group outsourcing.

The paper is organised as follows. Section 2 comments on the main contents of the debate about outsourcing and offshoring, focussing on the emphasis placed in the literature on how de-verticalisation of different functions and their spatial dispersion impact on innovation capabilities or respond to diversified innovation strategies. Section 3 introduces the dataset and descriptive statistics about outsourcing patterns in Lombardy. Section 4 presents the main econometric results on the effects of outsourcing on innovative output and performance. Section 5 concludes.

2 Outsourcing and innovation: the main issues

A great variety of approaches in both the economics and management literature have investigated the determinants and spatial characterisation of outsourcing, as well as its effects at firm and system level.

Transaction cost economics is a key starting reference with regards to both the functional dimension and the issue of suppliers' location. This perspective suggests that, in case of low uncertainty, reduced assets specificity and low frequency of interaction, firms would go for market instead of internalising activities (Williamson, 1985). This is typically the case of firms outsourcing ancillary services (e.g. logistics,

cleaning, IT, etc.) or the production of standard components. Cost saving is often a key rationale underlying such a strategy, whose recent upsurge is to be related with the increasing international competitive pressures (Feenstra, 1998) and gradual productive and commercial integration of low-cost emerging economies. Accordingly, the spatial distribution of the fragmentation activity mostly reflects cost differentials. Firms tend to take advantage of factor price differences across countries and regions, hence target productive locations characterised by lower labour costs, and sub-contract out to local suppliers.

On the other hand, transaction cost economics underlines the risks of outsourcing activities based on specific assets or under conditions of uncertainty, as it is often the case in R&D projects. Contractual arrangements are difficult to specify and monitor, and post-contractual opportunism is likely to occur, for example when R&D is of a proprietary rather than a generic nature (Walker and Weber, 1984; Williamson, 1985). In addition, externalisation of sensitive, knowledge intensive tasks can be detrimental for the firm innovative performance, as it increases the costs of transacting. In fact, organisations can prove more efficient carriers of knowledge than markets, as they are typically a more favourable locus for the development of a specific dialect for exchanging unstructured and tacit knowledge (Kogut and Zander, 1992; Mol, 2005). It follows that outsourcing of R&D related tasks makes sense only if relations with suppliers are stable and replicate some of the characteristics of the firms, rather than being of a strict arm's length type.

Adopting a transaction cost perspective, the main advantage of outsourcing non-strategic manufacturing tasks, in terms of innovative performance, is that it improves the financial position of the firm, since manufacturing costs decline and so the fixed investment in plant and equipment. A reduced financial burden implies that the firm can allocate resources to strategic activities while relying on specialised suppliers for non-strategic ones. In doing so, the firm can apply organisational structures and managerial practices that suit better its internal capabilities and competencies, and, accordingly, increase its efficiency.

However, the cost savings associated with outsourcing may not be as great as they seem, especially if fragmentation involves foreign suppliers (Gilley and Rasheed, 2000). The transaction costs associated with repeated overseas market relationships can be significant. Spatial dispersion can result in longer lead times, larger inventories, communication and coordination difficulties, reducing the advantage of lower fixed costs, reallocation of resources to strategic tasks and greater flexibility.

Focus on core competencies is a prominent advantage of outsourcing underlined in the contributions adopting a resource-based view of the firm (Prahalad and Hamel, 1990; Quinn, 1992; Barney, 1999). Outsourcing non-core activities allows the firm to increase managerial attention and resource allocation to those tasks it does best (Gilley and Rasheed, 2000). More focussed managers' and workers' commitment on core activities increases responsiveness and flexibility, generating beneficial impacts on the firm performance, particularly in markets and sectors characterised by high competitive pressure, short product life cycle and complex technologies. Moreover, the outsourcer is able to take advantage of suppliers' specialised knowledge and access emerging technologies without bearing the entire costs and risks for their development (Quinn, 1992). Outsourcers indeed encourage competition among suppliers, inducing them to specialise, and thereby sustaining the improvement of quality in services and products. Outsourcing is therefore an option for

complementing the firm specific competencies, while preserving and strengthening its core of capabilities.

There is a broad consensus among scholars about the positive effect on firm performance, including innovation, of outsourcing non strategic, ancillary activities. Some, although still scarce, evidence seems to confirm it (Gilley and Rasheed, 2000; Leiblein et al., 2002; Rothaemel et al. 2006).

More controversial and ambiguous is the effect of outsourcing core assets and activities, or those that are close to the core competences of the firm (Gilley and Rasheed, 2000). This means strategic manufacturing tasks, but also knowledge generating activities in support of the main business, such as, typically, design and R&D. The resource based view suggests that firms should not shift to external procurement when the function involves special firm capabilities and responds to strategic needs. This would undermine the firms' capacity to build and defend its differential performance. Furthermore, total or partial dismantling of core activities would negatively affect the firm absorptive capacity (Cohen and Levinthal, 1989). Firms that outsource R&D would lose touch with new technological developments and, more generally, diminish their capacity to scan the external environment and enter into knowledge related collaborations.

The current observed increase in the outsourcing of R&D activities does not necessarily contrast with this view. R&D outsourcing is compatible with the core competence view when one considers the routinisation of research and design functions. This process of commodisation has been pervading all manufacturing sectors, including high tech ones (Ernst and O'Connor, 1992). Commodisation of functions often reshapes firms' boundaries, as they find it preferable to fully outsource the commodised tasks and redirect their business towards higher value added activities.

A different perspective on the role and effects of outsourcing knowledge-intensive or strategic activities is provided by evolutionary contributions (Mahnke, 2001). These stress the impact of changing firm boundaries on the dynamic capabilities of the firm, hence on its ability to integrate, build and reconfigure internal and external competencies to address changing environments (Teece et al., 1997). Outsourcing can respond to the need of reaping specialisation gains while exposing to a variety of learning experiences. As products become more sophisticated and production relies on an increasing range of specialised technological understanding (Pavitt, 1998), firms are forced to seek outside support or collaboration with organisations having strengths in different fields. Outsourcing is therefore part of a knowledge-searching strategy and does not necessarily imply a decline in the firm own R&D activities. Rather than functioning as substitutes, independent suppliers complement in-house laboratories, taking part to the division of labour in research tasks (Arora and Gambardella, 1990; Howells, 1999).

However, the evolutionary perspective shares the view that a trade-off exists, such that cross boundaries management of strategic activities calls for attentive strategy. In fact, vertical disaggregation can contribute to combining complementary specialised knowledge and breaking competence traps, but may also undermine firm's absorptive capacity, if it implies dismissal of strategic capabilities (Mahnke, 2001).

A growing stream of studies relates distributedness of functions, or strategic "openness", to superior innovative performance. As value creating resources and capabilities ever more frequently reside across the boundaries of the firm (Gulati et al, 2000), the strategic advantage of internalising knowledge content activities erodes and

the firm becomes more porous and embedded in loosely coupled networks of different actors (Laursen and Salter, 2006). The "open innovation model" suggests that a central part of the innovation process involves the search and use of a wide range of external actors and sources (Chesbrough, 2003; Laursen and Salter, 2004 and 2006; Powell et al. 1996, 1999), and outsourcing can be part of a wider strategy for opening up to external ideas and knowledge.

Proximity matters for the decision to outsource core activities or searching for complementary strategic knowledge sources. In fact, knowledge exchange and coordination are made more difficult by distance and dispersion. Proximity facilitates the personal contacts that motivate and support the development of trust (Love and Roper, 2001), and it is likely to facilitate governance along the fragmented value chain. This is all the more evident when proximity is sided by clustering, which facilitates the creation of networks of co-production and subcontracting. A strong local supply chain, or other forms of local inter-firm networks, increase the scope for outsourcing and the opportunity for a more interactive approach to learning and innovation (Morgan, 1997). This argument is confirmed by robust econometric evidence showing that domestic partners generate a greater positive impact on innovative performance that foreign ones (Vinding, 2006). It also points toward the importance of stable and prolonged relationships (i.e. strong ties) for transferring complex knowledge and enhancing innovation (Hansen, 1999; Sorenson et al. 2006). As argued by Sorenson et al. (2006), simple knowledge can travel over long distances, so there is no significant difference between close and distant partners. Conversely, the greater the complexity of the knowledge required, the higher the importance of close ties, thus, in such a case, the searching strategy will privilege close partners.

However, recent advances in communication technologies, developments in the management and business processes, and the increasing openness of economies have made it easier to orient towards distant knowledge sources and global networks (Mol, 2005). Bardhan and Jaffe (2005) point out that experience accumulated in offshoring of manufacturing and service activity has served to open the door to exploring offshoring of R&D functions. Global dispersion of R&D also reflects the need for accessing talent and competencies from different contexts. Dispersed location of core assets generally follows orientation to global dispersed markets. When the firm expands into different markets, there is a need for adapting knowledge and procedures, and developing a "design and research" market strategy. This is all the more evident in large emerging markets, which present great development prospects and a large local pool of qualified human capital. The effectiveness of the global sourcing strategy is however strongly related with the organisation capacity of the firm, challenged by the difficulties of coordinating dispersed assets.

Spatial dispersion of high value added activity tends to be mediated with organisational proximity. Intra-group offshoring is in fact highly significant in the case of R&D, reflecting importance to safeguard proprietary business procedures and intellectual property rights (Bardhan and Jaffe, 2005). This also reflects interest in direct organisational proximity with other local sources of knowledge, especially when overseas R&D activities are located in technologically specialised environments.

A similar argument has been also put forward by the global value chain literature, which suggests that the governance structure of producer-supplier relations tends to become more hierarchical as soon as the complexity of the knowledge transferred increases (Gereffi, Humphrey and Sturgeon, 2005). Therefore, we observe the

emergence of loose networks when transactions do not entail complex tasks and can be governed by well codified procedure, while more tight ties, or even sourcing to foreign affiliates occur when task are complex and/or no reliable partners are available. As pointed out above, along this line of reasoning the transaction cost economics argues that internalisation is required under uncertainty and high asset specificity. Thus, we would expect firms either not to outsource their R&D activities or to involve close actors, such as affiliates.

3 Data description

The data for the empirical analysis are drawn from an original firm-level survey conducted in 2005[2]. The investigation concerns the main manufacturing sectors of Lombardy, Italian leading economic region, characterised by a fully fledged and mature industrial system, interested by a substantial process of tertiarisation, but still exhibiting an important manufacturing core. The industrial texture of the region is highly diversified, characterised by multiple specialisation and by the relevant presence of both high tech multinationals and small firm-based traditional industrial districts. The openness of its economy makes the region particularly exposed to international changes and pressures, as well as to the processes of fragmentation that run through the integrated global economy.

The sample includes 1,148 regionally-based firms, accounting for 93,504 employees, which have been extracted from the national firm Census (Istat, 2001) according to three stratification criteria: geographical location, manufacturing activity and firm size. Four geographical macro areas, exhibiting significant within-group similarities in terms of productive specialization, and eight industry macro sectors were considered for stratification[3]. As far as the size dimension (number of employees) is concerned, the EU classification was taken into account. Five stratification cells were therefore considered, excluding micro firms (less than six employees)[4].

[2] The design of the sample, the data collection and the sampling procedure were carried out as part of the project "Survey sulle imprese e sulla struttura economica lombarda – Settore manifatturiero" sponsored by the *Istituto Regionale di Ricerca della Lombardia (IRER)* in 2006. Data were collected through telephone interviews conducted by a company specialised in surveying data with the assistance of the CATI procedure.

[3] The four areas are: Milan; North-East (Varese, Como, Lecco and Sondrio); North-West (Brescia and Bergamo); South (Pavia, Lodi, Cremona, Mantova).

The eight macro-sectors are: energy & chemistry (i.e. mining, extraction of crude petroleum and gas, coal and lignite, chemistry, rubber and plastic, electricity, gas and water supply); food & Tobacco (i.e. food products, beverages and tobacco); textile & clothing (i.e. textile, wearing apparel, tanning and leather, footwear); wood & furniture (i.e. wood and product of wood, furniture); paper & publishing (i.e. publishing, printing and reproduction of recorded media); mechanics & transport (basic metals, other non metallic mineral products fabricated metal products, machinery and equipments, motor vehicles, jewellery); electronics & optics (i.e. electrical machinery, radio communication equipment and apparatus, precision and optical instruments, watches and clocks, accounting and computing machinery); construction (i.e. construction and housing).

[4] (1) 6-9; (2) 10-49; (3) 50-249; (4) 250-499; (5) more than 500.

The Mechanics & Transport macro-sector accounts for the relative highest share of firms in the sample (34.8%), followed by Textile & Clothing (14.5%), Energy & Chemistry (14.5%) and Construction (12.5%). The sample includes prevalently small and medium-sized firms (about 50% of our firms belong to the 10-49 employees' class). The share of SMEs is particularly dominant in the Wood & Furniture industry and in Construction, where about 2/3 of the firms have less than 50 employees. On the other hand, a non-negligible share of large firms characterises a few sectors, such as Energy & Chemistry, Paper & Publishing and Mechanics & Transport.
The questionnaire used for the survey provides a wide range of information. Besides general information about the firm, the questionnaire focused on three main topics: organisational structure and its dynamics, internationalisation and innovation. First, the questionnaire investigated the organisational structure of the firm, intended as the range of functions performed inside it, and the changes occurred over time by way of outsourcing. In particular, the survey provides detailed information on the type of activities outsourced and their localisation: whether they were sourced out locally (inside the region), nationally or abroad. It is worth to stress the narrow definition of outsourcing employed. Firms were asked specifically about the contracting out of activities that were previously carried out inside the firm.
Further, the survey investigated the firm internationalisation behaviour: export intensity and direction, FDI content and localisation. Finally, a section was devoted to explore the innovation performance of the firms, which were asked to specify whether they had recently (last three years) introduced either product or process innovation and to what extent the latter one contributed to their sales.

4 The geographical and functional dimensions of outsourcing

Outsourcing strategies have been implemented extensively by Lombardy firms. About half of the firms in the sample have sourced out at least one activity, and the phenomenon is uniformly distributed across industries. We observe only two significant exceptions, Paper & Publishing and Electronics & Optics, which represent, respectively, the upper (60.7% of firms outsourcing) and the lower (42.5%) tails of the distribution (Table 1).

The geographical reach
Outsourcing is clearly a domestic based strategy, in fact the large majority of firms (97,2% of all outsourcing firms) choose a supplier within the national boundaries. Moreover, outsourcing has also a clear regional dimension: on average more than 83% of outsourcers (firms outsourcing at least one function) rely upon a regional supplier and about 62% do so exclusively (Table 1). This pattern clearly appears in sectors that are strongly embedded in the regional industrial districts, such as Wood & Furniture, Textile & Clothing and Mechanics & Transport, or that are locally based businesses, such as Construction. This evidence is consistent with contributions which state that local knowledge and supply chains, territorial specific inter-firm and inter-personal networks substantially increase the scope of outsourcing (e.g. Morgan, 1997).

Table 1 - Outsourcing, by industry (% firms)

Industry	*% Outsourcers*	*of which (%share)*		
		*Ex. Regional Outsourcers**	*Regional Outsourcers§*	*Off-shorers°*
Energy & Chemistry	51.53	57.14	82.14	17.86
Food & Tobacco	50.00	48.00	76.00	16.00
Textile & Clothing	47.90	58.75	82.50	25.00
Wood & Furniture	50.00	56.76	83.78	2.70
Paper & Publishing	60.71	47.00	70.59	8.82
Mechanics & Transport	48.25	64.25	83.94	16.06
Electronics & Optics	42.55	52.50	75.00	32.50
Construction	54.17	82.05	94.87	3.85
Total	49.74	61.82	83.19	15.76

*Firms outsourcing *exclusively* within the region.
§Firms outsourcing *at least* one activity within the region.
°Firms outsourcing *at least* one activity abroad.

International outsourcing is a strategy followed by a minority of firms (7,8% of all firms in the sample) and it is unevenly distributed across sectors. It does not come as surprise that Electronics & Optics and Textile & Clothing are the sectors which are mainly concerned by this phenomenon. Their share of international outsourcers is much above the average, being equal to nearly 1/3 in the first industry and 1/4 in the latter.

The functional and organisational dimensions of outsourcing

It is reasonable to expect that the extent of outsourcing as well as its degree of geographical dispersion will depend on the characteristics of the activity concerned, and that those activities are outsourced differently across industries, reflecting industry differences in terms of competitive factors, competitive strategies of the firms and comparative advantages of the territories. Accordingly, we differentiate the functions being outsourced and explore the relationship between outward orientation, the type of activity and the governance regime involved (i.e. outsourcing to affiliate company vs. outsourcing to independent suppliers).

We analyse the functional scope of outsourcing referring to three types of functions: production and assembling, R&D and design, and services[5]. Before discussing the results it is important to notice that some firms do not carry out some of these activities. In particular, a small share of firms (3%) never carried out any production/assembling activity. As far as the service function is concerned, nearly a 15% share of firms does not have this function internally. This share rises considerably for the R&D function: more than 26% of firms in the sample never performed this activity. Having said that, we can add further insights by looking at the direction of outsourcing. Table 2 presents the types of activities outsourced by geographical location. These figures only consider firms that have/had those functions in-house. As expected, nearly 40% of the firms outsourced some kind of ancillary service. Among them, 98% referred, at least for one of the externalised activities, to domestic suppliers, whilst a smaller, but still high share sourced out to exclusively to

[5] The service category includes information services, human resource management, logistics and distribution, packaging, machine maintenance.

regional contractors (66% of all outsourcers). This clearly indicates that the local market for services is thick, that is, most firms have a preference for establishing linkages with geographically close actors, even for standardised activities, although exclusively regional outsourcing is relatively less common. As far as R&D is concerned, among firms performing some type of related activity outsourcing is less frequent. It also emerges, as for services, that suppliers are prevalently searched in the domestic and regional markets. Nevertheless the share of firms looking for international suppliers is the highest among the three main functions, and comparable to the one observed in relation to production. It can be argued that this strategy mainly characterises multinational firms, which source out to their affiliates abroad. This is in fact what we observe in our sample, when firms decide to offshore R&D activities, they refer to affiliates abroad more frequently than in the case of production and ancillary services.

Table 2 - Direction of outsourcing, by localisation (% of potential outsourcers*)

Function	***%Outsourcers***	***of which (%share)***		
		Ex. Regional Outsourcers[§]	***Domestic Outsourcers[+]***	***Off-shorers°***
Production/Assembling	24.06	59.33	95.15	16.79
R&D/ Design	18.52	59.49	89.24	18.35
Services	39.51	66.41	97.66	10.94

*Firms performing or having performed the function
[§] Firms outsourcing *exclusively* within the region.
[+] Firms outsourcing *at least* one activity within the country.
°Firms outsourcing *at least* one activity abroad

On average outsourcing is directed to organisational distant partners, that is firms that are not participated by the outsourcer. More than 80% of offshorers outsourced to independent contractors, compared to 50% that sourced out to affiliate firms (Table 3). R&D/Design activities, however, are kept closer to the firm organisational boundaries. In fact, only 65.5% of offshorers decided to turn to independent suppliers, which is about equal to the share of those supplying to affiliates (62% of all offshorers).

Table 3 - Direction of outsourcing, by localisation (% of potential outsourcers*)

Function	***% Off-shorers***	***of which (%share)***	
		No affiliates	***affiliates***
Production/ Assembling	4.04	84.44	55.56
R&D/ Design	3.40	65.52	62.07
Services	4.32	88.10	50.00
Total	7.84	83.33	50.00

5 Econometric analysis of the relationship between outsourcing and innovation

5.1 Model and variables

We model innovation by firms as a function of a number of variables reflecting firm-specific characteristics, while accounting for sectoral specificities. In particular, we estimate two different probit models, in order to assess the possible distinct relevance of these characteristics for the probability of a firm performing product vs. process innovation. In both cases, the dependent variable is a dummy variable. In the product innovation equation this is equal to one when the firm declared it introduced new products[6] over the recent 3-year period, while in the process innovation equation it is equal to one when the firm declared it introduced new processes over the same period. Simple descriptive statistics suggest that process and product innovations are distinct, in the sense that one of the two activities does not necessarily imply the other: approximately 40% of the firms in our sample that have introduced a process innovation does not introduce a product innovation (and viceversa). Indeed, process innovation is considered to be cost reduction driven, while product innovation is more likely to be oriented towards product differentiation. Then, one would expect that each type of innovation will be affected in a different way by the explanatory variables.

We then estimate a third model where the dependent variable is continuous and equal to the logarithm of the share of sales related to newly introduced products. This measure accounts for innovative intensity and also for the importance of the firm's innovative performance (as measured by the introduction of new products) for its overall performance.

The two probability models for the introduction of a product or a process innovation and the linear model explaining innovative performance are estimated as a function of firm's size (measured by the log of the number of employees: *Log(size)*), R&D intensity, measured as the log of R&D spending divided by total sales (*Log(RD/sales)*), fixed investment intensity (also relative to total sales: *Log(I/sales)*), human capital endowment, measured as the log of the share of employees having at least secondary education (*Log(HK)*), other firm characteristics and industry effects. This can be thought as estimating a sort of innovation production function at the firm level.

For a given R&D intensity and human resources, which we can directly control for, the size of the firm may influence the innovation output due, for example, to differences in other physical and financial resources across firms with different size. In general, a positive effect of size on innovation output (both in product and in process) is expected, since larger firms tend to be less financially constrained. However, larger firms may be subject to more bureaucratic controls and dysfunction which may affect negatively their capacity to translate R&D efforts into innovations. Moreover, if size is positively associated with market power, larger firms view themselves as less threatened by competition and their incremental benefits of innovation may be relatively lower compared to small firms (Pavitt et al., 1987).

The characteristics of the production technology may also affect the decision to

[6] Both novelty for the firm and/or novelty for the market are considered, as the question in the survey does not differentiate between them..

introduce innovations for a given level of R&D intensity. To differentiate production technologies we can only employ the intensity of investment physical capital. If, to exploit the innovation, high investment in physical capital is required, then we might expect this variable to have a positive effect on innovation. This might be the case of firms with more capital intensive technologies. However, it may also happen that more capital intensive processes provide less room for innovation since they are more automated and rigid. The final effect of investment intensity on innovation activity is therefore uncertain.

With reference to the firm level characteristics, in all estimated equations we introduce one or more indicator variables to represent the firm's outsourcing strategy. Exploiting the richness of our data, different components of such a strategy are presented and combined in the various specifications. We start from introducing a simple and raw indicator of whether the firm has (at least partially) outsourced any activity (*outsourcing*) and then specify the phase of the production process that has been outsourced, distinguishing between production and assembly (*phase1*), R&D and design (*phase2*) and services (*phase3*). In accordance with the results from the descriptive analysis, we further add the geographical dimension distinguishing between activities outsourced exclusively within regional boundaries (*exreg*) and activities outsourced also outside such boundaries, either to national or international contractors (*other*). We finally concentrate on foreign outsourcing (*offshoring*), that is on the situation in which geographical distance between outsourcer and outsourcee is "the farthest", and try to assess whether organizational distance does play an effect. This is evaluated distinguishing between activities outsourced at least partially to foreign members of the same group (*affiliated*) and activities outsourced exclusively to non affiliated firms (*not_affiliated*). We might expect that the sourcing out of complex tasks to non affiliated suppliers generates risks of opportunism and of knowledge leakages towards competitors, whose effects can in turn be detrimental for the innovative activity of the outsourcers.

In order to correctly assess the relevance of firms' outsourcing strategies for their innovative output and performance, we further control for the outward orientation of the firm. In particular, the outward orientation of the firm seems to be an important control for offshoring behaviour: in a recent paper, Cusmano, Mancusi and Morrison (2007) find that a strong relationship exists between international outsourcing behaviour and foreign business experience, as represented by both export activity and foreign direct investment (FDI). Hence we use two indicators that should convey information on the firm business experience in foreign countries: export intensity (*Log(export/sales)*) and an indicator variable, which takes the value 1 if the firm has undertaken foreign direct investment (*FDI*). We expect that export activity favours innovation, as their presence in foreign markets may require more innovations in order to be competitive. But it is also true that firms with more innovation activity may have more incentives to export since they also have more intangible resources to sustain growth. So, no clear direction of the causality may be established and we shall control for this potential reverse causation effect in the estimation.

In all specifications a dummy variable (*foreign control*) is used to indicate if the firm is (at least partially) controlled by foreign ownership. We also introduce a dummy variable that identifies firms engaged in the production of final goods (*final product*) to account for the differentiated behaviour of firms operating at different stages of the value chain.

Table 4 - Explanatory variables: descriptive statistics

Variable	*Mean*	*Std. Dev.*	*Min*	*Max*
Log(size)	3.42	1.25	1.79	8.52
Log(RD/sales)	0.69	1.02	0	4.62
Log(I/sales)	2.27	1.94	-6.25	10.82
Log(HK)	3.11	1.21	0	4.62
Log(export/sales)	2.02	1.74	0	4.62
FDI	0.12	0.32	0	1
Foreign_control	0.26	0.44	0	1
Final Product	0.81	0.40	0	1
Outsourcing	0.50	0.50	0	1
Outsourcing_phase1	0.23	0.42	0	1
Outsourcing_phase2	0.14	0.35	0	1
Outsourcing_phase3	0.34	0.47	0	1
Offshoring_phase1	0.04	0.19	0	1
Offshoring_phase2	0.03	0.16	0	1
Offshoring_phase3	0.04	0.19	0	1

As further controls, we also introduced a dummy indicating whether the firm is involved in R&D cooperation with other firms and/or institutions, a dummy for the firm being located in an industrial district which is specialised in the same sector of activity as the firm itself, a set of dummies to account for firm's age[7], and a set of geographical dummies. All these variables might affect the firm's ability to introduce a new product or process through learning, knowledge spillovers and experience. However, none of them is ever found significant in any specification. Hence we decided to exclude them from the analysis and not to include them in the final specification.
Table 4 reports descriptive statistics for the explanatory variables. Sample correlations among the included explanatory variables are very low, the highest being the correlation between Log(size) and Log(export/sales) (0.41) and that between Log(size) and FDI (0.40).

5.2 Results

All models are estimated accounting for the effects of sampling design on population estimates by using pseudo-maximum likelihood methods and allowing for probability sampling weights and stratification. The results are reported in Table 5 through Table 8.
Export intensity is itself a measure of firm's performance, which might be affected by innovation. This relates to the hypothesis of innovation-driven exports, whereby innovation is a prerequisite for firms to gain access to foreign consumer bases via exports. If export intensity were indeed endogenous, our estimates would be inconsistent and our interpretation flawed unless we properly instrumented for the endogenous variable. To test this hypothesis we use the Wald test of exogeneity, employing a set of instruments not included in our regressions. These are: (a) the

[7] From the survey we do not know the exact firm age, but only if it is in the following ranges: (1) less than 5; (2) between 5 and 9; (3) between 10 and 14; (4) between 15 and 20; (5) over 20.

logarithm of the per-capita GDP of the geographical area[8] that accounts for most of the firm's export, where per-capita GDP is evaluated in 2002 (i.e. the first year of the survey period); (b) a dummy equal to one if the firm belongs to a group; (c) a dummy equal to one if the firm's main competitors are foreign firms; (d) a set of dummies to account for firm's age[9]; (e) a set of geographical dummies.

This test is reported in the last line of Table 5 through Table 7 and confirms that in our data export intensity does not appear to be endogeneous with respect to product innovation and innovative performance, as, for both, the test fails to reject the null of exogeneity in each specification. By contrast, the test strongly rejects the null of the exogeneity of Log(export/sales) for process innovation. For this reason, we perform maximum likelihood instrumental variable probit estimation, which is reported in Table 8[10].

All specifications include 1099 out of the original 1148 observations (firms) because of the exclusion of some observations due to a few outliers and some missing values. To save space, industry effects are not reported in the tables, although included and jointly significant in all relevant specifications.

Before moving to the discussion of the results it is important to emphasize that we will limit our comments to the direction of the effect of the explanatory variables on the considered measure of innovation and interpret it in terms of correlation as we can only partially control for demand factors and market effects (in particular competition conditions) using dummies for large industry aggregates, while we cannot possibly control for firm specific effects such as managerial ability or experience.

With reference to the traditional determinants of innovation, we find that, as expected, R&D intensity has a positive and significant effect on all our innovation variables. By contrast, size has no effect on the probability of process innovation, while it has a negative and significant effect on the probability of product innovation and on our related measure of innovative performance. This contrasts with the results in Cohen and Klepper (1996) and Martinez-Ros (1999). Both find that large firms have a greater incentive to pursue both process and product innovations, with large firms' R&D cost spreading advantage being particularly pronounced for process relative to product R&D. Our result is instead in line with the findings in Pavitt et al. (1987) and suggests that small firms may benefit more by the introduction of new products and that the incidence of such products on their total (smaller) sales might be more pronounced.

The introduction of a new process is positively associated with spending on new fixed capital, while this has no effect on product innovation, however measured. This may be consistent with an important role for embodied technological progress (Parisi et al., 2006) and might suggest that high investment in physical capital is required in order to exploit process innovation. The opposite result is found on human capital, which is positively associated with the introduction of, and the returns from new products, while it has no significant relationship with process innovation. This evidence

[8] The geographical areas indicated in the survey are the following: EU15, new EU members, non-EU East Europe, South Mediterranean, North America, Central and South America, China, SouthEast Asia and Japan, Switzerland, Australia and New Zealand, Middle East. Per-capita GDP was obtained from UNCTAD and is evaluated in current US dollars.

[9] See footnote 7.

[10] However, the results are virtually identical to those presented in Table 5, with the only exception of the constant and the industry dummies.

supports the idea that qualified human capital is especially important for triggering the emergence of new products, as argued, for instance, by Branzei and Vertinsky (2006).
With reference to our controls, we find that outward orientation, as expressed by both export intensity and FDI, influences the probability to innovate in product and its returns, but not the probability to introduce process innovations. This result is consistent with the finding of a larger impact of export activity in product innovation in Martinez-Ros (1999). The evidence is consistent with the resource-based view of the firm, which underlines the beneficial learning effects of being exposed to sources of knowledge and technologies which are wider than those in the home market (the so called "learning-by-exporting"). Exporting firms take advantage of diverse inputs and international competition stimuli to foster product innovation or diversification. Foreign control is positively related to the probability of introducing both process and product innovations (although less clearly so in the latter case) and with the product-related innovative performance of firms. This may suggest a weakness of the production system of Lombardy (and perhaps more generally of Italy), where foreign participation or control might better endow firms with capabilities and resources to innovate both in process and in product.
Direct participation to final market does not appear to foster the ability to introduce new products or the benefits gained from this kind of innovation, while it is negatively associated with the introduction of new processes. This means that the less a firm is involved in downstream activities aimed at the production and commercialization of final goods, the more it is likely (and possibly relevant) that it focuses on process innovations.
Finally, with reference to our key variables of interest, our results emphasize two key points. First, we find that outsourcing always shows a positive correlation with innovation and that this is mostly due to outsourcing of services, that is activities less subject to uncertainty and asset specificity. The positive relationship of innovation with service outsourcing is in line with the contributions stressing the advantages for firms of focussing on their core competences. The associated savings in costs are likely to improve a firm's financial prospects and free resources that the firm can allocate to strategic activities, while specialised suppliers take care of non-strategic ones.
Second, we find that proximity matters, both in the geographical and in the organizational space. Indeed, we find that the positive effect on innovation of service outsourcing is always related to local outsourcing, that is, to outsourcing within regional boundaries. The result holds for both product and process innovation. Whereas the literature has been mostly emphasising the relevance of proximity for the decision to outsource core activities, we find that proximity matters also for searching for complementary non strategic knowledge sources. The presence of a strong local supply chain, or other forms of local inter-firm networks, may increase the scope for outsourcing, facilitate knowledge exchange and coordination and thus favour a more interactive approach to learning and innovation, even when it comes to supportive, ancillary activities.
When firms decide to outsource activities far in the geographical space, that is when they decide to revert to foreign outsourcees, it appears to be of utmost importance to keep these activities close in the organizational space. Indeed, outsourcing of any function exclusively to non affiliated firms shows a negative correlation with the probability to introduce new products and the associated benefits. The result therefore applies also to the case of services, whose shift to provision by non-affiliate

contractors seems to reduce the occurrence and intensity of product innovation. It is also interesting to note that the offshoring of R&D and design activities is positively associated with product innovation and innovative performance, when the outsourcee is a member of the same group as the outsourcer. Hence, externalisation of sensitive, knowledge intensive tasks is not necessarily detrimental for the firm innovative performance if these tasks are entrusted to other actors within the same (extended) organizational boundaries, as this may not negatively affect transaction costs and the firm absorptive capacity.

INSERT Table 5,6,7,8 HERE

6 Conclusions

Outsourcing has been extensively investigated in the economic and the management literature, however very few empirical studies have so far explored the impact of outsourcing on firms' innovative performance. This paper contributes to the existing literature by assessing the geographical and functional dimensions of outsourcing and their impact on the innovation output of firms located in a mature industrial system.

Overall, results indicate that outsourcing is a very pervasive phenomenon encompassing to a similar extent all firms and sectors. However not all the activities within the firm are concerned with the same intensity. Ancillary services, such as logistic, IT services, maintenance of machines, represent the most outsourced activities, followed by a non negligible share of production and assembly activities and, to a less extent, by R&D ones.

Similarly, the geographical reach of outsourcing is not homogeneous across firms. In spite of the increasing attention paid by the economic literature, international outsourcing represents a minor fraction of the whole phenomenon, which mainly concerns firms already active in the international markets. Indeed outsourcing is prominently a regional phenomenon. Moreover, when international outsourcing concerns strategic or core activities (e.g. design/R&D), it often implies some kind of organisational proximity (e.g. the contractors is an affiliate firm of the outsourcer).

The econometric estimates add further insight to the above picture. Overall outsourcing strategies have a positive impact on the firms' innovative performance. In particular, the outsourcing of service activities contributes the most to innovation. This seems to suggest that firms successfully pursue core strengthening strategies, implying the sourcing out of ancillary activities, such as IT services or logistics, which are supplied by specialised external contractors, while firms focus on their core activities. Indeed, this process enables firms to free financial resources, which can be directed to areas in which their competitive advantages reside, but also, and perhaps more importantly, it increases specialised learning and managerial attention to core activities, making the firm internal management more efficient.

Results also indicate quite clearly that geographical proximity matters. The positive association of services with innovation is strongly related to the regional dimension, which points toward the importance of local user-producer relationships. These latter in fact contribute to generate both pecuniary and knowledge externalities at the local level, in the form of specialised markets for input and technology, high skill workers and through labour mobility. A further reason for local networks being preferred, is possibly that they consent to build trust and commitment, and in turn to avoid

communication and coordination failures, which are, on the other hand, quite common in long distant networks.

Proximity also matters in organisational terms. When outsourcing crosses national borders, it appears to be critical to keep the outsourced activities at least loosely connected to the firm. Indeed, offshoring of any function to non affiliated firms has a clear negative impact on innovation. Further evidence supports this latter argument, we find that when suppliers belong to the same group as the outsourcer, international outsourcing of R&D and design activities is positively associated with innovation. This entails that firms openness generate real opportunities of learning if strong, stable and trusty relationships are in place, as those that supposedly hold between members of the same group.

Table 5. Probit regressions – Dependent variable: I(Process Innovation)

	(1)	(2)	(3)	(4)	(5)
Log(size)	0.05	0.05	0.04	0.05	0.05
	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)
Log(RD/sales)	0.19***	0.19***	0.20***	0.20***	0.20***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Log(I/sales)	0.05**	0.05**	0.05**	0.05**	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log(HK)	-0.06	-0.05	-0.05	-0.04	-0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Log(export/sales)	0.03	0.03	0.03	0.03	0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
FDI	0.27	0.25	0.29	0.24	0.26
	(0.20)	(0.19)	(0.19)	(0.19)	(0.20)
Foreign_control	0.34***	0.35***	0.35***	0.36***	0.36***
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Final Product	-0.24**	-0.23*	-0.24**	-0.22*	-0.21*
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Outsourcing	0.31***				
	(0.10)				
Outsourcing_phase1		0.12			
		(0.12)			
Outsourcing_phase2		0.03			
		(0.15)			
Outsourcing_phase3		0.15			
		(0.11)			
Outsourcing1_exreg			0.13		
			(0.14)		
Outsourcing 1_other			0.15		
			(0.19)		
Outsourcing 2_exreg			0.13		
			(0.17)		
Outsourcing 2_other			-0.13		
			(0.27)		
Outsourcing 3_exreg			0.20*		
			(0.12)		
Outsourcing 3_other			0.01		
			(0.20)		
Offshoring_phase1				0.03	
				(0.27)	
Offshoring_phase2				0.00	
				(0.40)	
Offshoring_phase3				-0.06	
				(0.28)	
Offshoring_phase1_affiliated					0.47
					(0.40)
Offshoring_phase1_not_affiliated					-0.21
					(0.38)
Offshoring_phase2_affiliated					-0.31
					(0.49)
Offshoring_phase2_not_affiliated					0.18
					(0.51)
Offshoring_phase3_affiliated					-0.51
					(0.44)
Offshoring_phase3_not_affiliated					0.17
					(0.35)
Constant	-0.62**	-0.58**	-0.60**	-0.51**	-0.52**
	(0.26)	(0.26)	(0.26)	(0.25)	(0.25)
Observations	1099	1099	1099	1099	1099
Prob>F	0.00	0.00	0.00	0.00	0.00
Test of joint significance of industry effects (p-value)	0.15	0.17	0.12	0.22	0.21
Wald test of exogeneity (p-value)	0.00	0.00	0.00	0.00	0.00

Standard errors in parentheses. Industry dummies included in all regressions. * 10%, ** 5%, *** 1% significance

Table 6. Probit regressions – Dependent variable: I(Product Innovation)

	(1)	(2)	(3)	(4)	(5)
Log(size)	-0.11*	-0.11*	-0.11**	-0.11**	-0.12**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Log(RD/sales)	0.36***	0.35***	0.36***	0.37***	0.37***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Log(I/sales)	0.02	0.02	0.02	0.02	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log(HK)	0.07*	0.07*	0.07*	0.09**	0.09**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Log(export/sales)	0.11***	0.12***	0.12***	0.12***	0.13***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
FDI	0.47**	0.46**	0.50***	0.48***	0.45**
	(0.18)	(0.18)	(0.19)	(0.19)	(0.18)
Foreign_control	0.20	0.20	0.20	0.23*	0.22*
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Final Product	0.02	0.03	0.01	0.01	-0.02
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Outsourcing	0.26**				
	(0.10)				
Outsourcing_phase1		0.05			
		(0.12)			
Outsourcing_phase2		0.08			
		(0.16)			
Outsourcing_phase3		0.23**			
		(0.12)			
Outsourcing1_exreg			0.04		
			(0.15)		
Outsourcing 1_other			0.13		
			(0.19)		
Outsourcing 2_exreg			0.18		
			(0.18)		
Outsourcing 2_other			-0.12		
			(0.27)		
Outsourcing 3_exreg			0.27**		
			(0.13)		
Outsourcing 3_other			0.14		
			(0.20)		
Offshoring_phase1				0.04	
				(0.29)	
Offshoring_phase2				-0.13	
				(0.33)	
Offshoring_phase3				-0.32	
				(0.31)	
Offshoring_phase1_affiliated					0.57
					(0.41)
Offshoring_phase1_not_affiliated					-0.69*
					(0.42)
Offshoring_phase2_affiliated					0.73*
					(0.41)
Offshoring_phase2_not_affiliated					-0.96**
					(0.40)
Offshoring_phase3_affiliated					-0.10
					(0.41)
Offshoring_phase3_not_affiliated					-0.70*
					(0.40)
Constant	-0.97***	-0.98***	-0.99***	-0.85***	-0.80***
	(0.30)	(0.30)	(0.30)	(0.30)	(0.30)
Observations	1099	1099	1099	1099	1099
Prob>F	0.00	0.00	0.00	0.00	0.00
Test of joint significance of industry effects (p-value)	0.04	0.05	0.03	0.04	0.03
Wald test of exogeneity	0.21	0.15	0.26	0.65	0.37

Standard errors in parentheses. Industry dummies included in all regressions. * 10%, ** 5%, *** 1% significance

Table 7. OLS regressions – Dependent variable: Log(share of sales due to new products)

	(1)	(2)	(3)	(4)	(5)
Log(size)	-0.14**	-0.14**	-0.15**	-0.15**	-0.15**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Log(RD/sales)	0.46***	0.46***	0.46***	0.47***	0.47***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Log(I/sales)	0.04	0.04	0.04	0.04	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Log(HK)	0.08*	0.08*	0.08*	0.09**	0.09**
	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
Log(export/sales)	0.11**	0.11***	0.11***	0.11***	0.12***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
FDI	0.53***	0.52***	0.54***	0.53***	0.48***
	(0.19)	(0.19)	(0.19)	(0.19)	(0.18)
Foreign_control	0.28*	0.29**	0.29**	0.32**	0.31**
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
Final Product	0.09	0.11	0.09	0.09	0.06
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Outsourcing	0.24**				
	(0.11)				
Outsourcing_phase1		0.01			
		(0.14)			
Outsourcing_phase2		0.04			
		(0.17)			
Outsourcing_phase3		0.22*			
		(0.12)			
Outsourcing1_exreg			0.02		
			(0.16)		
Outsourcing 1_other			0.05		
			(0.21)		
Outsourcing 2_exreg			0.13		
			(0.20)		
Outsourcing 2_other			-0.10		
			(0.29)		
Outsourcing 3_exreg			0.25*		
			(0.13)		
Outsourcing 3_other			0.17		
			(0.23)		
Offshoring_phase1				-0.06	
				(0.32)	
Offshoring_phase2				-0.04	
				(0.34)	
Offshoring_phase3				-0.25	
				(0.37)	
Offshoring_phase1_affiliated					0.39
					(0.41)
Offshoring_phase1_not_affiliated					-0.86**
					(0.39)
Offshoring_phase2_affiliated					0.63*
					(0.33)
Offshoring_phase2_not_affiliated					-0.77**
					(0.33)
Offshoring_phase3_affiliated					0.03
					(0.52)
Offshoring_phase3_not_affiliated					-0.78*
					(0.46)
Constant	0.29	0.29	0.29	0.39	0.44
	(0.28)	(0.28)	(0.28)	(0.29)	(0.28)
Observations	1099	1099	1099	1099	1099
R-squared	0.19	0.19	0.19	0.19	0.20
Prob>F	0.00	0.00	0.00	0.00	0.00
Test of joint significance of industry effects (p-value)	0.00	0.00	0.00	0.00	0.00
Wald test of exogeneity	0.55	0.54	0.56	0.58	0.53

Standard errors in parentheses. Industry dummies included in all regressions. * 10%, ** 5%, *** 1% significance

Table 8. IV Probit regressions – Dependent variable: I(Process Innovation)

	(1)	(2)	(3)	(4)	(5)
Log(size)	0.04	0.04	0.03	0.03	0.03
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Log(RD/sales)	0.19***	0.19***	0.19***	0.19***	0.19***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Log(I/sales)	0.05**	0.05**	0.05**	0.05**	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log(HK)	-0.06	-0.05	-0.05	-0.04	-0.05
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Log(export/sales)	0.05	0.05	0.05	0.06	0.05
	(0.17)	(0.18)	(0.18)	(0.18)	(0.18)
FDI	0.26	0.24	0.27	0.23	0.24
	(0.22)	(0.22)	(0.22)	(0.22)	(0.22)
Foreign_control	0.34***	0.35***	0.35***	0.36***	0.36***
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Final Product	-0.24**	-0.23*	-0.25**	-0.22*	-0.21*
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Outsourcing	0.31***				
	(0.10)				
Outsourcing_phase1		0.11			
		(0.12)			
Outsourcing_phase2		0.03			
		(0.15)			
Outsourcing_phase3		0.15			
		(0.11)			
Outsourcing1_exreg			0.13		
			(0.14)		
Outsourcing 1_other			0.16		
			(0.19)		
Outsourcing 2_exreg			0.13		
			(0.17)		
Outsourcing 2_other			-0.12		
			(0.27)		
Outsourcing 3_exreg			0.20*		
			(0.12)		
Outsourcing 3_other			0.01		
			(0.20)		
Offshoring_phase1				0.03	
				(0.27)	
Offshoring_phase2				0.00	
				(0.40)	
Offshoring_phase3				-0.07	
				(0.28)	
Offshoring_phase1_affiliated					0.48
					(0.41)
Offshoring_phase1_not_affiliated					-0.23
					(0.41)
Offshoring_phase2_affiliated					-0.30
					(0.49)
Offshoring_phase2_not_affiliated					0.17
					(0.52)
Offshoring_phase3_affiliated					-0.51
					(0.45)
Offshoring_phase3_not_affiliated					0.16
					(0.36)
Constant	-0.59	-0.55	-0.56	-0.48	-0.49
	(0.37)	(0.37)	(0.37)	(0.37)	(0.38)
Observations	1099	1099	1099	1099	1099
Prob>F	0.00	0.00	0.00	0.00	0.00
Test of joint significance of industry effects (p-value)	0.00	0.00	0.00	0.00	0.00

Standard errors in parentheses. Industry dummies included in all regressions. * 10%, ** 5%, *** 1% significance

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